

1 WHAT IS CLAIMED IS:

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3 1. A pump comprising:

4 an actuator formed of a magnetostrictive material
5 susceptible to changes in physical dimensions in the
6 presence of a magnetic field;
7 first and second pumping chambers coupled to said
8 magnetostrictive element to vary in volume as said
9 magnetostrictive element changes shape.

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11 2. The pump of claim 1, wherein said first and second
12 pumping chambers are driven by opposite ends of said
13 magnetostrictive element, to change volume in phase with
14 each other.

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16 3. The pump of claim 2, wherein said magnetostrictive
17 element has a lengthwise extent, and said first and
18 second pumping chambers are driven by opposite ends of
19 said element at opposite ends of said lengthwise extent.

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21 4. The pump of claim 3, wherein said pumping first and
22 second chambers are located at opposing ends of said
23 lengthwise extent.

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25 5. The pump of claim 1, wherein said first and second
26 pumping chambers are driven by said magnetostrictive
27 element to change volume in opposing phase with each
28 other, so that one chamber has a maximum volume as the
29 other has a minimum volume.

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2 6. The pump of claim 5, further comprising a third pumping
3 chamber, driven by said magnetostrictive element to pump
4 in phase with one of said first and second pumping
5 chambers.

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7 7. A pump comprising:

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9 a housing defining a cylindrical cavity;
10 a cylindrical actuator formed of magnetostrictive
11 material, within said housing and coaxial therewith;
12 first and second pumping chambers within said housing at
13 opposite ends of a lengthwise extent of said
14 magnetostrictive element, each of said pumping chambers
15 mechanically coupled to said actuator, to compress as
16 said actuator extends in length.

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18 8. The pump of claim 7, wherein fluid in each of said first
19 and second pumping chambers is displaced by a lengthwise
20 extension of said actuator.

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22 9. The pump of claim 8, further comprising a third chamber
23 extending axially along a length of said actuator, fluid
24 in said third chamber displaced by a radial expansion of
25 said actuator.

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27 10. The pump of claim 9, wherein inlets of said first,
28 second, and third pumping chambers are fluidly coupled.
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1 11. The pump of claim 10, wherein outlets of said first,
2 second, and third pumping chambers are fluidly coupled.
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4 12. A pumping assembly, comprising a plurality of pumps in
5 accordance with claim 1, wherein inputs and outputs of
6 said plurality of pumps are interconnected in parallel.
7

8 13. The pumping assembly of claim 12, wherein each of said
9 plurality of pumps is driven out of phase with each other
10 one of said plurality of pumps.
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12 14. The pumping assembly of claim 13, comprising three
13 pumps.
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15 15. A pumping assembly, comprising a plurality of pumps in
16 accordance with claim 1, wherein inputs and outputs of
17 said plurality of pumps are interconnected in series.
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19 16. A method of pumping fluid using a magnetostrictive
20 element comprising:
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22 applying a magnetic field to a magnetostrictive element
23 to cause lengthwise extension of said element at two
24 opposing ends;

25 driving a first pumping chamber through said extension of
26 a first end of said two opposing ends;

27 driving a second pumping chamber through said extension
28 of a second of said two opposing ends, opposite said
29 first end,

1 wherein said first pumping chamber is driven in phase
2 with said second pumping chamber.

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4 17. The method of claim **16**, further comprising
5 allowing said magnetostrictive element to contract
6 lengthwise, and extend widthwise;
7 driving a third pumping chamber with said widthwise
8 expansion of said magnetostrictive element.

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